

Assessing Student Collaboration in Electronic Portfolio Construction: An Evaluation Research

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Abstract

Portfolios that provide evidence of pre-service teachers' professional growth development have been widely incorporated in teacher education programs (Barrett, 2001; Wilhelm *et al.*, 2006) and the question of how to use electronic portfolio to maximize their learning and professional development becomes interesting to many teacher educators. In a technology integration course offered to alternative teacher education programs at a southeastern state university, students were required to construct an electronic portfolio that demonstrated their competency in instructional design and in technology integration (Shoffner, 2007a). This study took an evaluation research approach to assess students' collaboration in their construction of electronic portfolios in the technology integration course. The assessments of the collaboration included 1) students' electronic portfolios, 2) students' self-assessment of the portfolios, collaboration and performance in collaboration, 3) collaboration experiences as described by the students, 4) impact on the course work, and 5) impact on their technology proficiency. This paper reports the assessment results and discusses implications for facilitating collaboration in portfolio construction for pre-service teachers.

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Introduction

Electronic portfolios have received increasing attention in teacher education and become popular in many teacher education programs (Lynch & Purnawarman, 2004). Students are required to construct their electronic portfolios for three purposes: 1) learning and professional development, 2) assessment of student learning and professional development, and 3) employment and job seeking. Portfolios, when functioning as mechanisms for learning, foster student learning and professional development by “complex thinking and creativity required in constructing multimedia-based and hypertext presentations (Jonassen, 1996)” (Lynch & Purnawarman, 2004).

This learning function of portfolio has been recognized by many scholars (Beck *et al.*, 2005; Hartnell-Young & Morris, 1999; Lynch & Purnawarman, 2004; Wilhelm et al., 2006). Barrett (2001) points out how construction of portfolio engage students in reflection and evaluation of their own thoughts. Zeichner and Wray (2001) show that portfolios encourage students “to think more deeply about their teaching and about subject matter contents, to become more conscious of the theories and assumptions that guide their practices, and to develop a great desire to engage in collaborative dialogues about teaching” (2001). Since many teacher education programs require students to construct electronic portfolios, the question of how to use electronic portfolio to maximize their learning and professional development becomes interesting to many teacher educators.

The Teacher Education Environments in Mathematics and Science (TEEMS) Programs are alternative paths to initial teacher certification at a southeast state university. Students who

finish the TEEMS Programs of study obtain a Master of Education degree and recommendation for initial teacher certification in the state. The university offers multiple sessions of a required technology integration course (IT 7360: Integrating Technology into School Based Learning Environments) for its TEEMS students every semester. The course is designed to help the TEEMS students meet the National Educational Technology Standards for Teachers (NETS) by the International Society of Technology in Education (ISTE) (Shoffner, 2007a). It is a three credit hour course that includes a series of assignments and construction of an electronic portfolio to demonstrate their competency in technology integration.

The previous course surveys and class observations in IT 7360 course discovered that students in TEEMS programs had low technology proficiency and limited understanding of the theoretical framework behind technology integration. These have presented a daunting challenge to both the TEEMS students and the course instructors of IT 7360 when TEEMS students were trying to complete their electronic portfolios.

Research Questions, Research Design, and Rationale

To meet this challenge and to maximize learning during portfolio construction, the TEEMS students were encouraged to construct their electronic portfolios collaboratively in the IT 7360 course. Since portfolio construction is usually individual work, is it appropriate to have students construct their portfolios through collaboration? To answer this major research question and to obtain a comprehensive picture of student collaboration in portfolio construction, following questions were also asked.

- 1) Did the collaboration produce better portfolios than those constructed individually?

- 2) How did students feel about their portfolio, collaboration, and performance in portfolio construction?
- 3) What was the experience like for students to collaborate in their electronic portfolio construction?
- 4) Did the portfolio collaboration impact student course work?
- 5) Did the portfolio collaboration impact students' technology proficiency?

This study took an evaluation research approach to assess students' collaboration in constructing electronic portfolios in a technology integration course for pre-service teachers. The evaluation research approach is defined as the application of research skills to determine the worth of an educational practice to aid in decision making in a particular educational environment. Evaluation differs from other research approaches not by its methods but most of all its purposes. According to Krathwohl (1998) and McMillan & Schumacher (2001), evaluation research has a number of unique characteristics:

- 1) Evaluation research is decision-driven instead of hypothesis-driven.
- 2) The value of evaluation research is in its utilization.
- 3) Because evaluation research is decision-driven, it takes holistic approach, which sees education as a complex human endeavor.
- 4) Evaluation does not control the study but explore the evaluation target as it is in actual situations.
- 5) Evaluation research uses multiplicity of data from different sources combining qualitative and quantitative data.

The use of evaluation research approach in this study was selected with following considerations. First, evaluation research fits the researcher's epistemological beliefs of social

cognitive learning that advocates learning through collaboration in real social contexts (Driscoll, 2000). The researcher believes that learning is not an individual act, even when undertaken alone (Duffy & Cunningham, 1996), and “knowledge does not reside with an individual learner alone” (Gunawardena & McIsaac, 2004), but is distributed among members of the community. Thus, assessment of learning and instructional strategies like collaboration must be carried out in the social contexts in which they are actually taking place.

Although collaboration is widely used in teacher education to facilitate learning, as a social phenomenon, collaboration is complex and frequently misunderstood (Youtz, 1997) with varied and multiple interpretations of its effects. Collaboration (working collaboratively) in electronic portfolio construction is new to many researchers. To better prepare pre-service teacher students for technology integration, the researcher needs comprehensive knowledge of their collaboration in electronic portfolio constructions and the impacts of collaboration on their learning and technology integration.

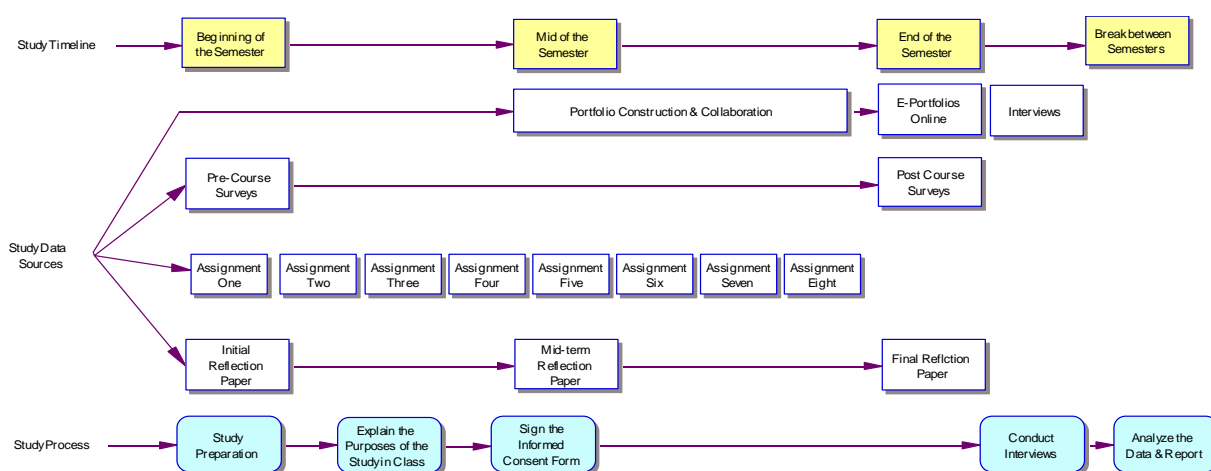
Finally, actual research and instructional contexts of the IT 7360 course impose limitations for using other research approaches that control and manipulate variables for study purposes.

Study Procedure and Participants

The study started the first week of the semester when students completed the pre-course surveys. In the fourth week, the instructor explained the study to the students and those who decided to collaborate in their portfolio construction for the course signed the informed consent forms. Student collaboration in their portfolio construction started in the eighth week at the mid-point of the semester. During collaboration for portfolio construction, they also completed three

course assignments individually. The interviews of study participants took place after the course instructor submitted course grade to avoid possible coercion on study participants. They were informed that all interviews were to be conducted individually, and their interview content would remain confidential and would not be revealed to others including their collaboration partners. Each interview was taped, transcribed into text, and then analyzed. Figure 1 reveals the relationship between the study timeline, data sources and study process.

Figure 1: Study timeline, data sources, and study process



Six TEEMS students participated in this study: four from the TEEMS program majoring in Math Education and two from the TEEMS program majoring in Reading and Language Literacy. The following section provides general descriptions of each participant in this study.

Alleena, a woman in her early twenties with a BA degree in English, worked for a very short while as a teacher assistant in a Sunday school. She was student teaching in a public school during the semester as her first formal teaching experience.

Anna, a woman in her late twenties with a BS degree in Mathematics, was a math teacher in a high school since January 2003 with a provisional teaching certificate (6-12 Math). She taught Algebra II, concepts of problem solving, and concepts of Algebra for 9-12 graders.

She worked in the same math Department with Megan with whom she collaborated in portfolio construction.

Brian, a man in his early thirties with a BS degree in Civil Engineering, was a math teacher in a high school since August 2003 with a provisional teaching certificate (5-8 Math). He taught mostly Algebra I & II at his school.

Camela, a woman in her mid twenties with a BS degree in Mathematics, was unemployed at the time and had no formal teaching experiences and no teaching certificate. She began student teaching Pre-Algebra (7th grade) during the semester.

Karl, a man in his early thirties with a BA degree in English, was an assistant librarian in a small public library. He was student teaching in a public school during the semester as his first school teaching experience.

Megan, a woman in her early thirties with a BA degree in Textile Engineering, was a math teacher in a high school since January 2003 with provisional teaching certificate (6-12 Math.). She taught Algebra II, Concepts of Problem Solving, and Concepts of Algebra, Probability & Statistics for 9-12 graders. She worked in the same Math Department with Anna with whom she collaborated in portfolio construction.

Assessment Framework

In order to make appropriate instructional decisions regarding student collaboration in their portfolio construction in this technology integration course, the instructional effects of collaboration must be comprehensively assessed. Table 1 described the relationships between assessment questions, target of assessment, instruments and procedures used in this evaluation.

Table 1: Assessment question, targets of assessment, instruments and procedures

Questions	Targets of Assessment	Instruments	Notes
1. Did collaboration produce better portfolios than those constructed individually?	Electronic portfolios developed collaboratively and individually	Electronic portfolio assessment rubric	Electronic portfolios were assessed by invited assessors.
2. How did students feel about their portfolio, collaboration, and performance?	Student satisfaction over portfolios, collaboration, and performance in collaboration	(1) The survey of the satisfaction over portfolio, collaboration, and performance (2) Students' final reflection paper	Data were analyzed by the researcher.
3. What was the experience like for students to collaborate in their electronic portfolio construction?	Collaboration experiences as described by the students	Recorded interviews with collaboration students	Interviews were conducted by the researcher
4. Did the portfolio collaboration impact student course work?	Course assignments	Assignment rubrics	Assignments were assessed by the invited assessors.
5. Did the portfolio collaboration impact their technology proficiency?	Collaboration impact on their technology proficiency	Pre-and-post Course Technology Proficiency Self-Assessments	Data was analyzed by the researcher.

Assessment Results and Analysis

Data analysis in this study included 1) assessment of electronic portfolios, 2) students' self-assessment of the portfolios, collaboration and performance in collaboration, 3) collaboration experiences as described by the students, 4) impact on the course work, and 5) impact on their technology proficiency.

Assessment of electronic portfolios

The assessment of electronic portfolios was to answer the follow question: "Did collaboration produce better portfolios than those constructed individually?" An assistant

professor, and two doctoral students of instructional technology were invited to assess electronic portfolios using an assessment rubric developed by Shoffner (2007b). The assistant professor had taught the IT 7360 course and assessed student electronic portfolios every semester for the past three years. The two doctoral students had gone through a short training on how to use the rubric to assess student electronic portfolio. The invited assessors assessed one portfolio and discussed uses of the rubrics together to address the inter-rater reliability issue of using the rubric. And then, they assessed the electronic portfolios independently.

The rubric had seven assessment items, and each item had four assessment categories with an assigned point value from “Needs Improvement (0 – 3.5)”, “Meets Criteria (4)”, “Exceed Criteria (4.5)” to “Excellent (5)”. The points in each item were multiplied by 2, 3, or 4 before they were accumulated into the final total points. The maximum value for the portfolio was 100. The average of assessed items from each assessor was used to determine the quality of these electronic portfolios. Twelve electronic portfolios were assessed and among them, three were constructed through collaborations. Table 2 displayed the means (M) and standard error of means (SEM) of each assessed item between collaboration portfolio group and individual portfolio group.

Table 2: Means and standard error of means of assessed items in portfolio assessment

Assessment Items	Collaboration Portfolios N =3		Individual Portfolios N=9	
	M	SEM	M	SEM
Item 1	9.56	0.11	8.89	0.21
Item 2	14.67	0.17	13.22	0.49
Item 3	9.67	0.33	7.96	0.35
Item 4	18.67	0.39	16.59	0.55
Item 5	18.89	0.59	16.89	0.37
Item 6	15.00	0.00	14.33	0.17
Item 7	8.78	0.29	7.96	0.27
Item total	95.22	1.15	85.85	2.05

Item 1: Statement of personal educational philosophy
Item 2: Description of the learning environment

Item 3: Description of the physical space for the learning environment
Item 4: Descriptions of the unit/lesson Plans developed for the learning environment
Item 5: Development of the learning environment materials
Item 6: Appropriate content
Item 7: Usability of the online learning environment developed
Item total: Item 1 + Item 2 + Item 3 + Item 4 + Item 5 + Item 6 + Item 7 = 100

The assessment results indicated that the portfolios constructed through collaboration received higher average points than those that were constructed individually. The total mean score for the collaborated portfolios was 95.22, and the total mean score for the individual portfolios was only 85.85. Mann-Whitney Test (Sprent & Smeeton, 2001) was used to determine if the difference was significant in each assessed item. This test is a non-parametric alternative to the two-sample t test, but makes no assumptions about the distribution of data. So Mann-Whitney Test works particularly well for small sets of data. Table 3 displayed the Mann-Whitney Test results between the collaboration portfolio group and the individual portfolio group.

Table 3: Results of Mann-Whitney Tests on assessed items

	Mann-Whitney U ^a	Z	Exact P (one-tailed)
Item 1	4.00	-1.849	0.050*
Item 2	5.00	-1.600	0.073
Item 3	5.00	-2.434	0.005*
Item 4	3.00	-1.966	0.032*
Item 5	1.50	-2.267	0.009*
Item 6	3.00	-2.044	0.032*
Item 7	4.00	-1.795	0.050*
Item total	1.00	-2.311	0.009*

Item 1: Statement of personal educational philosophy

Item 2: Description of the learning environment

Item 3: Description of the physical space for the learning environment

Item 4: Descriptions of the unit/lesson Plans developed for the learning environment

Item 5: Development of the learning environment materials

Item 6: Appropriate content

Item 7: Usability of the online learning environment developed

Item total: Item 1 + Item 2 + Item 3 + Item 4 + Item 5 + Item 6 + Item 7 = 100

a. The details of calculating U statistic and significance level can be found in Sprent and Smeeton (2001). Here is an easy interpretation: if the difference between group 1 and group 2 is large, then the U statistic is small, the Z value is always negative, and the P value is small.

* $P \leq .05$

As indicated by Table 3, the mean differences between collaboration portfolios and individual portfolios were significant ($P \leq .05$) in all assessed items except *Item 2: Description of the learning environment* with a P value of .073. The data analysis of portfolio assessment results determined that the collaboration in portfolio construction produced better portfolios than those constructed individually in this IT 7360 class.

Student self-assessment of their collaborations

The purpose of the student self-assessment was to determine how the students felt about their collaboration. Student who collaborated in their portfolio construction were asked to fill out a simply survey rating their satisfaction regarding their portfolios, collaboration, and performance in collaboration at the end of the course. The self-assessment provided insights of their collaboration from student perspectives. Table 4 summarized the survey results which indicated that students felt very positive about their collaboration and its results.

Table 4: Student's satisfaction over portfolio, collaboration, and performance

	The Portfolio	Collaboration	Self Performance in Collaboration	Partner's Performance in Collaboration
Aleena	9	9	10	8
Anna	9	10	10	10
Brian	8	10	9	9
Camela	9	10	10	10
Karl	10	9	8	10
Megan	10	10	10	10
Maximum Points	10	10	10	10

The final course reflection paper had five questions focusing on student's understanding of technology integration. Although the paper was not specifically designed to help students

reflect on their portfolio collaboration, it was hoped that analysis of their reflection paper would reveal additional insights into their portfolio collaboration. In answering the fifth question, “How do you plan to keep up with changes in technology as you move through your teaching career?”, some students who collaborated in the portfolio construction mentioned collaboration or clearly indicated their readiness to collaborate with other teachers in the future as revealed by their statements below.

I plan to make sure that I am reading educational journals, attending conferences, and collaborating with other teachers so that I can learn about and have the opportunity to use technology that will help me teach and will help my students learn. (Megan)

A primary characteristic of technology is ever-changing. In order to stay current, I will continue to read extensively mathematics and technology related journals, discusses technology integration issues with my colleagues, and work with them to solve technology related problems. (Brian)

I think another way that I can stay up to date with technology is to ask my colleagues and coworkers and even to collaborate with them on some technology integrating projects. (Camela)

To conclude, according to the survey data and reflection papers, students were very satisfied with their collaboration experiences in portfolio construction and felt very positive about their collaboration.

Collaboration experiences as described by the students

“What was the experience like for students to collaborate in their electronic portfolio construction?” was the question used to reveal the essence of student collaboration in portfolio construction. The collaboration experiences as described by the students offered unique insights about their collaboration from student perspectives. Each student who collaborated in portfolio construction was interviewed by the researcher individually. The themes that emerged from

interview data analysis included “defining collaboration”, “unique ways of collaboration”, “exciting moments”, “about collaboration partner”, and “frustrations.”

Defining collaboration

Although the study participants had their own definitions about their collaboration in electronic portfolio construction, they all agreed that it was serious undertaking with “a big task” and pressures of “deadlines.” The participants did not talk as much about responsibilities, roles, and goals as the researcher had expected. They defined their collaboration as simply “working together” to get things done, “to solve your problems”, “fun” and “part of our life”, “things we do often...”, “wonderful learning experience”. They all had very similar definitions for their collaborations.

“Well, it’s simply working together, you know, to get things done. Creating our portfolio, you know, was a big task and ... Working with [name omitted] made things much easier. You don’t have to always stand on your own. Just like you have your buddy.... working together, especially the one that you have collaborated before and you know [name omitted] is good on this.” (Anna, p. 3)

“Working together to solve your problems... It’s fun and it’s part of our life, things we do often. We always collaborate in our math courses and it was just another wonderful learning experience with her...” (Megan, p. 4)

“Collaboration is a way to get busy and crazy... As a matter of fact, we accomplished a lot each time we work together...but sometimes, especially when you see the deadline was just around the corner, Oh, man...”(Alleena p.3)

Unique Ways of Collaboration

Two students worked in the same school and lived close to each other but quite a distance from the University. Most of the collaboration work was completed on the way to the university and on the way back home. Their descriptions created an interesting picture that mirrored their collaboration experiences.

“We designed our layout that evening at [the university name]. Then we revised the layout on the drive home. We rode together to school... Entire drive home, we completed the page layout and divided the [web] pages to work on... the drive was about 40 to 60 minutes, we discussed portfolio all the way home.” (Anna, p.15)

“We also discussed our assignment on the way home, we spoke so loud in the car... We also planned our assignments for the class around the portfolio so that we had a really cool Polynomials theme that we can now use in our classrooms.” (Megan, p.16)

“As much as I hated driving to Atlanta, the drives seemed to allow us to get so much done. Sometimes we would talk about other things, but in the car proved to be the most convenient time for us to think aloud and discussed our ideas. I also enjoyed every minutes of working with [name omitted]. We were able to help each other and improve our teaching abilities and give each other wonderful ideas. It always made the driving home so fast” (Brian, p.15)

Their collaboration also took place in a very casual environment like in a café. A student described their collaboration experience in a café near the university.

“So we went to Heavenly Café. We were supposed to talk about our teaching that day, ... I couldn't remember what we said. It was not a good one. But I remember we had course materials all over the table... He typed in everything we discussed... in his computer while I was reading to him the portfolio requirements and other course materials and sometimes I was thinking and talking to myself. He's so funny. He typed everything I said in his computer... Before I finished my coffee, I knew what we would do for the portfolio. (Karl p.4)

Exciting moments

The energy and excitement of collaboration were obvious in above description. Yet the more obvious exciting moments were those when they were “in the zone,” when they saw “the light at the end of the tunnel,” and when they saw their great accomplishment.

“We felt that we were in the zone...Everything just fits in ...we knew we would finish it that day and the portfolio was great, all of our documents were in place and links were fine, everything was fine, we were in the zone, in the zone, you know!” (Brian, p.16)

“Exciting moments... The moment when we finished our portfolio. It was a great day, and I was in the lab first. [Name omitted] came in late and I remember it was Saturday...He asked me ‘Are you ready? Let’s finish it today.’ He sounded so confident and ... Almost instantly, um... I saw a light at the end of the tunnel. That moment...was so exciting!! That day was just a great day!” (Camela, p.20)

“I showed our portfolio to my students, my daughter and husband and I also showed it to my colleagues at school. I got great response like ‘Good grief, how much did you guys do this semester.’ It was exciting when you heard comments like this and you know that you did a great job. It’s a big accomplishment. I was extremely proud...” (Megan, p.22)

“We checked all the links and images on our portfolio on another computer. At that moment, the portfolio suddenly became mine. We worked on it for weeks and I felt so weird that it suddenly... like your baby was born. It was the most exciting and it was weird too... Anyway, it was exciting. The portfolio site was extremely comprehensive and others could definitely use it.” (Anna, p.23)

About collaboration partner

All the study participants enjoyed their collaborations, and spoke highly of their collaboration partner. The study participants had very positive experiences of collaborating with their partners before the collaboration in their electronic portfolio construction. Collaboration to them was just “things we do often...” Their positive comments on their collaboration partners revealed their satisfaction with collaboration and also indicated the importance and impact of the positive pre-collaboration experience with their partners on their collaborations in electronic portfolio construction.

“We collaborate in our work at school and in our study at [the university name]. She is my buddy and she is so quick on things and always has a lot of wonderful ideas. I knew we would do a great job! I mean in portfolio” (Anna, p.7)

“He is very professional, always on the top of things, very detail oriented, trustworthy and easy to work with. We worked together before... we are very different but we like each other. I enjoyed working with him...he’s a great guy to work with.” (Camela, p.7)

“We did two big course projects last summer and it worked quite well...She always knows what to do and always get things done fast. ...In an intensive

program like Math TEEMS, you want to work with a colleague like her.”(Anna, p.9)

Frustrations

Frustrations experienced during their collaboration revealed the obstacles that impeded their collaboration and should get our attention. These moments of frustration indicated that the collaboration format, tools, individual working styles, and even physical well-being were important factors that contributed to their frustration.

“Definitely, I hope to have more visualized collaborations... synchronized but visualized when we were working at home. We talk a lot on our cell phones. But really hope to see ...I am a visual learner. I need sometimes to see what was on her screen... If I could do that, some problems we talked for hours could be solved, you know, just one click.” (Brian, p.16)

“The E-Locker (a web format file transferring protocol that university offers to all the students to access their files on university network drive) was not user-friendly, we tried a few times to upload our portfolio files through it. Oh, it was horrible. We ended up with broken links, and missing images, and our pictures were gone... And we decided that we need to work together at the computer lab downstairs.” (Alleena, p.11)

“Find a good chunk of time to work together was always a problem. Let’s me take that back, it’s not really a problem but it’s difficult. Difficult, you know what I mean. I need a big chunk of time to work on it. It’s just me. I can not work 30 minutes on the portfolio and shift gears to work on something else for another hour and then come back to work on portfolio again. It’s just not me.” (Brian, p.14)

“Sometimes we were so tired after our evening class when we met in the lab. We sat there doing nothing ... I was tired, I wanted to go home, and sleep.” (Karl, p.16)

From the descriptions above, it was clear that students were generally positive about the collaboration experiences which echoed with the survey results of their satisfaction about their collaboration. Although there were frustrations, to collaborate in the electronic portfolio

construction was just another satisfactory experience of “working together” and “solving your problems” and collaboration is fun and part of their life.

Impacts on the course work

The assessment effort in this section tried to answer question: “Did the portfolio collaboration impact student course work?” The course work assessed included eight assignments, three of which were done after students started their portfolio collaboration. The three assignments were Assignment 6, Integrating MS Excel in instruction; Assignment 7, Integrating MS Access in instruction, and Assignment 8, Evaluation of online resources and evaluation of educational resources (software and media). Both assignments before and after student portfolio collaboration were assessed to determine the impacts of portfolio collaboration on the course work. Table 5 reported the means (M) and standard error of means (SEM) of the assessment results for the eight assignments between collaboration portfolio group and individual portfolio group.

Table 5: Means and standard error of means of assignments

Assessment Items	Collaboration Portfolios N =6		Individual Portfolios N=9	
	M	SEM	M	SEM
Assignment 1	4.83	0.037	4.52	0.080
Assignment 2	5.69	0.049	5.61	0.043
Assignment 3	4.69	0.045	4.68	0.047
Assignment 4	5.68	0.069	5.69	0.063
Assignment 5	4.87	0.049	4.56	0.283
Assignment 6	5.87	0.045	5.71	0.057
Assignment 7	4.78	0.049	4.76	0.033
Assignment 8	6.78	0.049	6.56	0.123
Assignment total	43.18	0.302	42.08	0.500

a. Assignment total = Assignment 1 + Assignment 2 + Assignment 3 + ...Assignment 8.

b. Maximum value of Assignment total is 54.

The Mann-Whitney U Test results indicated that significant differences ($P \leq .05$) existed on students' assignment total between portfolio collaboration group and individual portfolio group.

Table 6: Results of Mann-Whitney U Tests on assignments

	Mann-Whitney U	Z	Exact P (one-tailed)
Assignment 1	5.00	-2.643	0.001*
Assignment 2	15.50	-1.375	0.091
Assignment 3	27.00	.000	0.500
Assignment 4	26.00	-.119	0.478
Assignment 5	21.50	-.677	0.265
Assignment 6	12.00	-1.784	0.044*
Assignment 7	21.00	-.726	0.265
Assignment 8	19.00	-.955	0.194
Assignment total	12.00	-1.769	0.044*

* $P \leq .05$

Although there was a significant difference in Assignment total according to the test, the contributions of the significance were not just from assignments done concurrently with the portfolio collaboration. Thus, there was no evidence to believe that collaboration in portfolio construction made any impact on student assignments though it was expected to be the case.

Impacts on technology proficiency

The impacts of collaboration on student technology proficiency were assessed by Technology Proficiency Self-Assessment (TPSA) created by and used with permission of Dr. Margaret Merlyn Ropp (n.d.). The TPSA survey consisted of 20 items of a five point Likert scale questionnaire asking about the confidence in performing technology related tasks from sending e-mails to writing up a budget plan for purchasing technology equipment for classroom uses. The survey statement started with "I feel confident that I could..." for each item. The same TPSA was administered at the beginning of and at the end of the course. The differences

between the pre-course and post-course TPSA were used to determine the impacts of portfolio collaboration on TEEMS students' technology proficiency.

The data analysis coded "Strongly Disagree" as "1" and "Strongly Agree" as "5".

Results indicated that differences existed between the pre-course and post-course TPSA results for both collaboration portfolio group and individual portfolio group. Table 7 displayed their means and standard error of means.

Table 7: Means and standard error of means of TPSA results

Assessment Items	Collaboration Portfolios N =6				Individual Portfolios N=9			
	Pre-Course		Post Course		Pre-Course		Post Course	
	M	SEM	M	SEM	M	SEM	M	SEM
1	5.00	0.00	5.00	0.00	5.00	0.00	5.00	0.00
2	4.83	0.17	4.67	0.21	3.78	0.55	4.63	0.25
3	4.00	0.45	4.50	0.22	3.44	0.44	4.38	0.25
4	4.83	0.17	5.00	0.00	4.89	0.11	4.87	0.12
5	3.17	0.83	5.00	0.00	3.89	0.51	4.63	0.17
6	4.50	0.22	5.00	0.00	4.44	0.35	4.88	0.12
7	4.50	0.22	5.00	0.00	4.44	0.24	4.75	0.15
8	1.17	0.17	5.00	0.00	2.11	0.56	5.00	0.00
9	3.67	0.56	5.00	0.00	3.89	0.51	4.75	0.15
10	3.83	0.31	4.67	0.21	4.11	0.31	4.75	0.15
11	3.67	0.56	4.33	0.49	3.56	0.53	4.75	0.24
12	2.67	0.67	4.83	0.17	3.00	0.60	4.38	0.25
13	2.67	0.62	4.83	0.17	3.33	0.62	4.38	0.25
14	4.33	0.49	4.33	0.49	3.56	0.65	4.63	0.17
15	2.83	0.31	4.12	0.17	2.78	0.52	4.38	0.31
16	3.50	0.43	4.67	0.33	4.11	0.42	4.63	0.17
17	4.33	0.21	4.33	0.42	3.56	0.47	4.38	0.25
18	3.50	0.50	4.67	0.21	3.67	0.47	4.38	0.25
19	2.50	0.34	4.17	0.48	2.89	0.45	4.13	0.33
20	2.33	0.21	3.5	0.43	2.78	0.32	3.88	0.38

Wilcoxon Signed Ranks Test was used to determine if differences between pre-course and post-course TPSA were significant ($p \leq .05$). This test is a non-parametric alternative to paired t test. Wilcoxon Signed Ranks Test makes no assumptions about the distribution of data and works well for small sample sizes.

Table 8: Significant results of Wilcoxon Signed Ranks Test between pre-course and post-course TPSA

Assessment Items	Collaboration Portfolios N =6			Individual Portfolios N=9		
	Sum of Rank	Z	Exact P (one-tailed)	Sum of Rank	Z	Exact P (one-tailed)
3				18.50	-1.725	0.042*
6	6.00	-1.732	0.042*			
7	6.00	-1.732	0.042*			
8	21.00	-2.333	0.010*	28.00	-2.530	0.006*
9	10.00	-1.857	0.032*			
12	15.00	-2.041	0.021*			
13	15.00	-2.032	0.021*			
15	21.00	-2.271	0.012*			
16	10.00	-1.841	0.033*			
18	15.00	-2.041	0.021*			
19	19.50	-1.913	0.028*	18.50	-1.701	0.045*
20	18.50	-1.725	0.042*	15.00	-2.070	0.019*

* $P \leq .05$

According to the test results, eleven out of twenty survey items were significant in portfolio collaboration group and four, in individual portfolio group. These results indicated that students in the portfolio collaboration group had made more significant improvement in their confidence to perform those technology related tasks than the students in the individual portfolio group. To answer the assessment question for this section, the collaboration did produce positive significant impact on students' technology proficiency in IT 7360 course.

Discussions

Since portfolio construction is usually individual work, is it appropriate to have students construct their portfolios through collaboration? According to the assessment results and analysis presented above, the answer to this research question is positive.

The assessment results indicated that collaboration in electronic portfolio construction in this technology integration course worked very well by producing better electronic portfolios, creating positive learning experiences and generating positive impact on students' technology proficiency. The study results echo with findings from other scholars that collaboration as a learning strategy is usually effective in promoting student learning and performance (Johnson & Johnson, 2004) and collaboration generally has more advantages than working individually because of positive inter-dependence, individual accountability, promotive interaction (Johnson & Johnson, 2004), and access to and combination of complementary expertise (Hara *et al.*, 2003; Maglaughlin & Sonnenwald, 2005).

There are a number of advantages to having students collaborate in electronic portfolio construction. First, collaboration needs clear goals to sustain it. An electronic portfolio gives students a good and sustainable reason to collaborate because of its specific requirements and foreseeable collaboration outcomes.

Second, construction of an electronic portfolio is a big undertaking that offers rich content for students to collaborate at different project levels. Their collaborations in portfolio construction covers a wide span of tasks including designing portfolio content, structure, and layout, forming instructional goals and objectives for their learning environment, and designing and developing instructional materials. Collaboration with their peers on these different tasks fosters their learning and reflection about instruction at different levels.

In addition to the collaboration content, the length of time required to complete portfolios is also very favorable. The portfolio collaboration lasted for seven weeks in this study. It gives students who collaborate enough time to understand each other's personality, social skills, working styles, and related expertise. Consequently, it offers them enough time to build

up their social bonds and trust in completing required tasks for portfolio construction. Again with favorable timing on the student side and positive interdependence (Johnson & Johnson, 2004) built, more and deeper meaningful learning and reflection on learning and instruction are likely to occur among those pre-service teachers as they collaborate in their portfolio construction. These benefits of collaboration can also be used to explain the positive assessment results this study produced.

Furthermore, this study revealed that pre-service teachers today were more ready to work collaboratively. The interview data and reflection papers clearly indicated that all the students who collaborated in electronic portfolio construction had positive collaboration experiences and were more ready to collaborate in the future after their electronic portfolio collaboration. This implies that positive collaboration might have a lasting effect on students' future collaboration and teacher educators should be prepared to facilitate student collaboration to help them create positive collaboration experiences.

The comprehensive assessments of student collaboration in portfolio construction also produced some interesting insights about collaboration in addition to producing better portfolios and positive feelings about their collaboration. The collaboration in portfolio construction did not produce any impact on the course work. This suggests that collaboration does not always produce impacts on other related work. There are a number of possible explanations behind this. First, collaboration takes time to produce an impact on other related work. In this case, the collaborating students did their last three assignments in the first four weeks of the portfolio collaboration. There was not enough time for the collaboration to make any significant impact on their assignments. Second, the impacts of collaboration might be content related. The content of portfolio collaboration in the first four weeks was mainly about designing the portfolio,

establishing goals of learning environment to be created, exploring related academic standards, and analyzing their learners. These tasks were not closely related to the content of the assignments students completed at the time. Therefore, portfolio collaboration could hardly make a clear impact on those assignments.

This study offers one way to comprehensively assess students' collaboration in portfolio construction. Two limitations of this study must be mentioned here. First, the study participants were offered the opportunity and then self-determined to collaborate in this study. Many other possible influencing factors, such as collaboration as a preferable learning strategy, more experiences on teaching and technology integration, and cognitive ability (Devine & Philips, 2001), were not controlled because of the practical constraints. Second, because of the practical constraints, the invited assessors did not discuss the uses of assessment rubrics for assignments to address the inter-rated reliabilities. Though this might not alter much of the assignment assessment results, inter-rated reliability remained an issue to be addressed in a future study.

In spite of these limitations, the study suggests that collaboration in electronic portfolio construction is an innovative and effective way to help pre-service teachers meet those identified challenges of low technology proficiency and limited understanding of theoretical framework behind technology integration. Students should be encouraged to construct their electronic portfolio collaboratively in the technology integration course to maximize their learning and professional development.

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